PSYCHOLOGY 305
COGNITIVE PROCESSES

Agenda

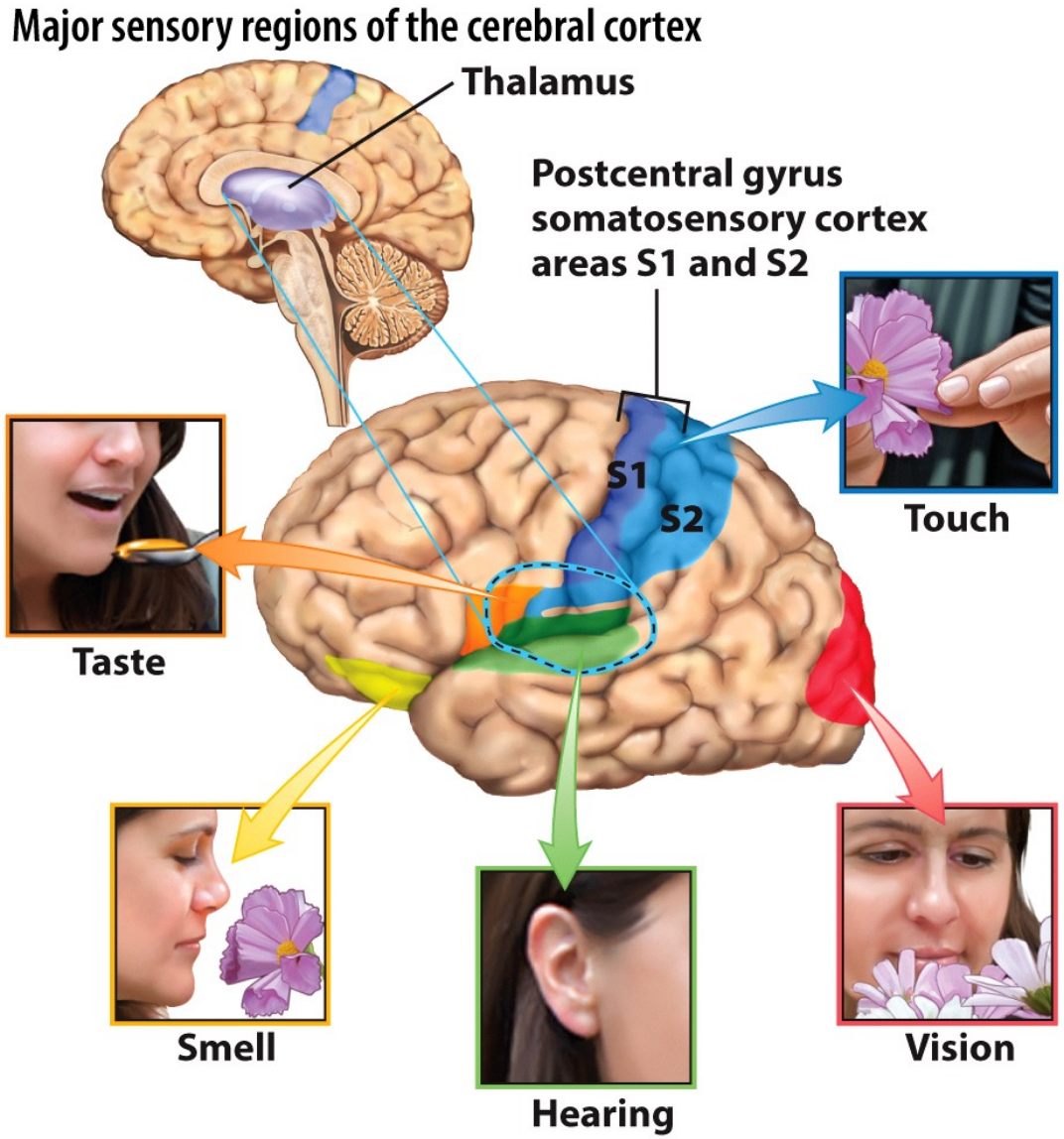
Finish methods

Vision: Visual hierarchy

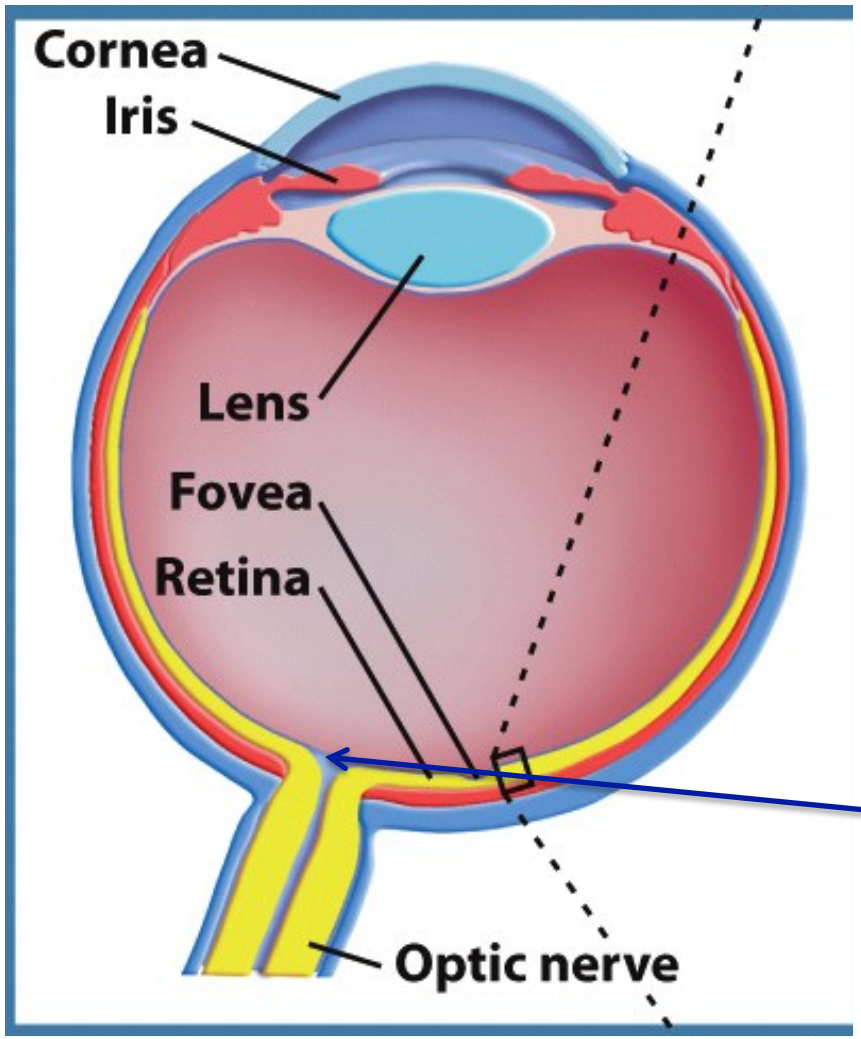
Flexible mapping between external world and perception

We will focus on vision

Other sensory modalities will not be tested



How is light converted into neural signal at retina?

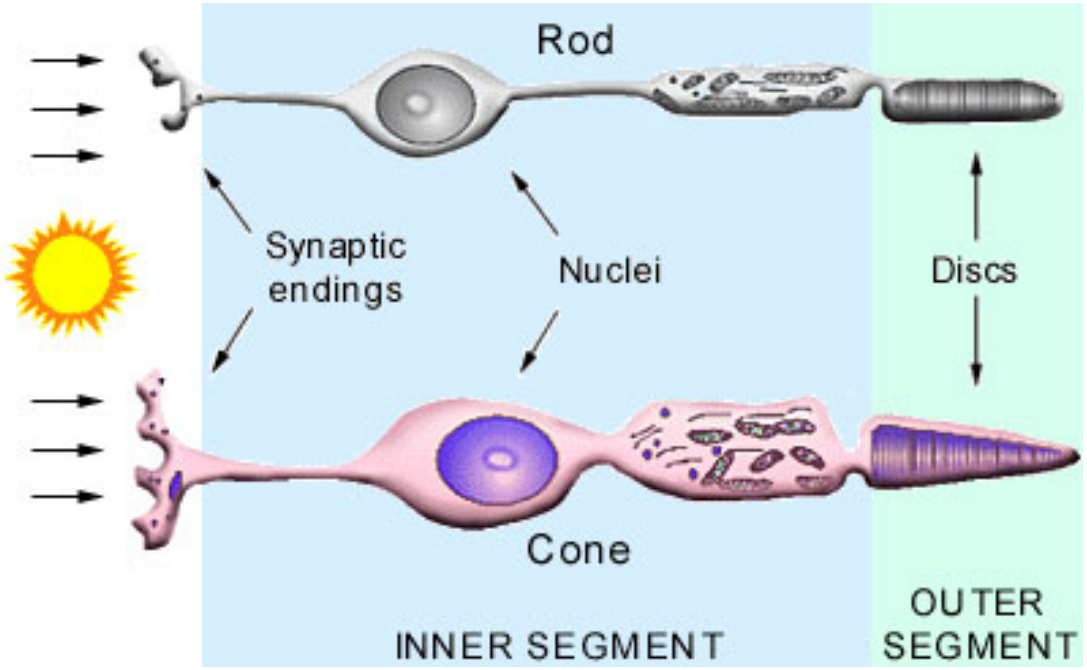


- Photoreceptors/retina located at the back of the eye.
  - pick up light and *transduce* light into signals
- information carried up optic nerve.

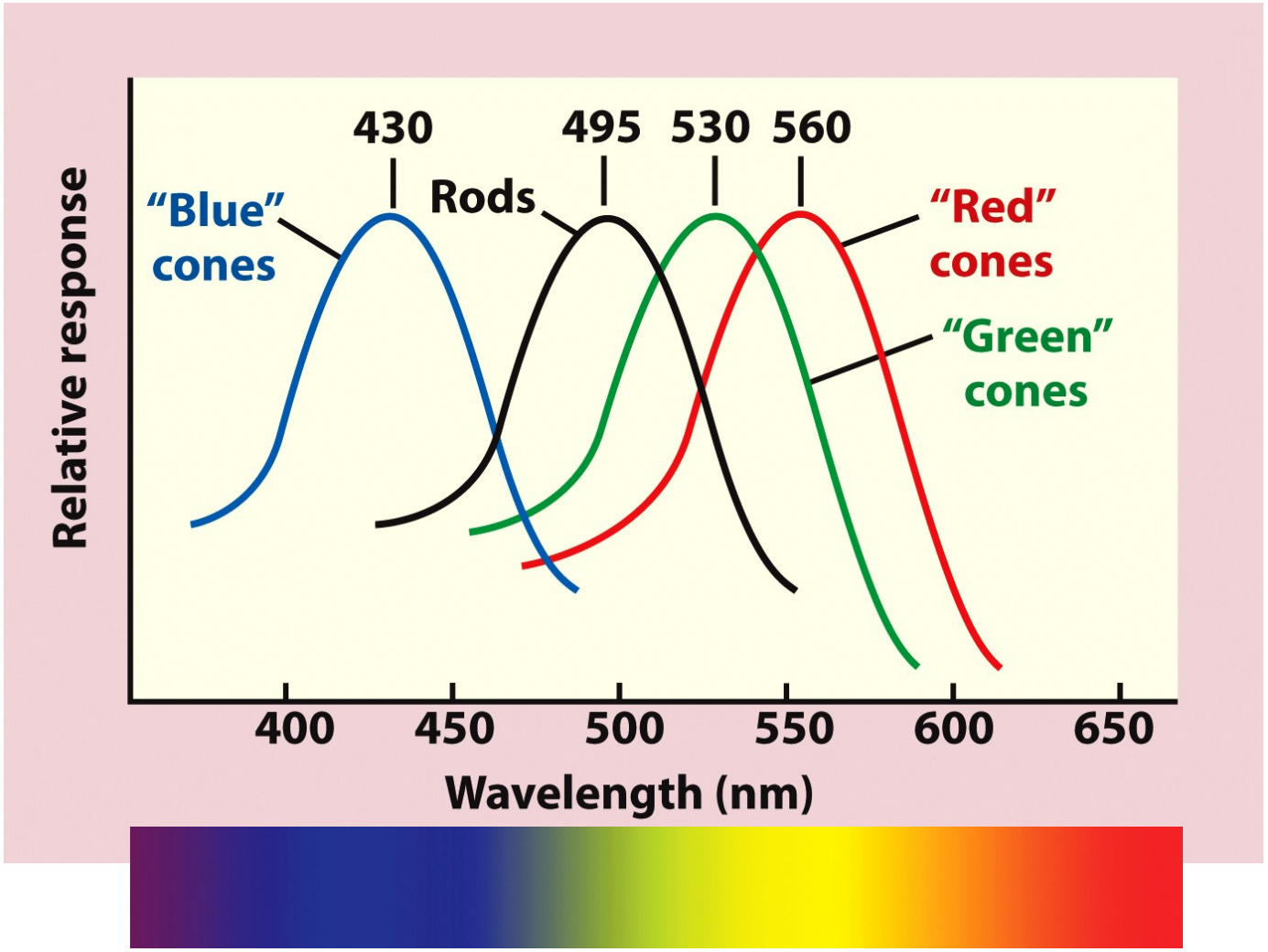
Blind spot

Rods and cones

- Rods – black and white
  - Most sensitive
- Cones – color
  - Less sensitive

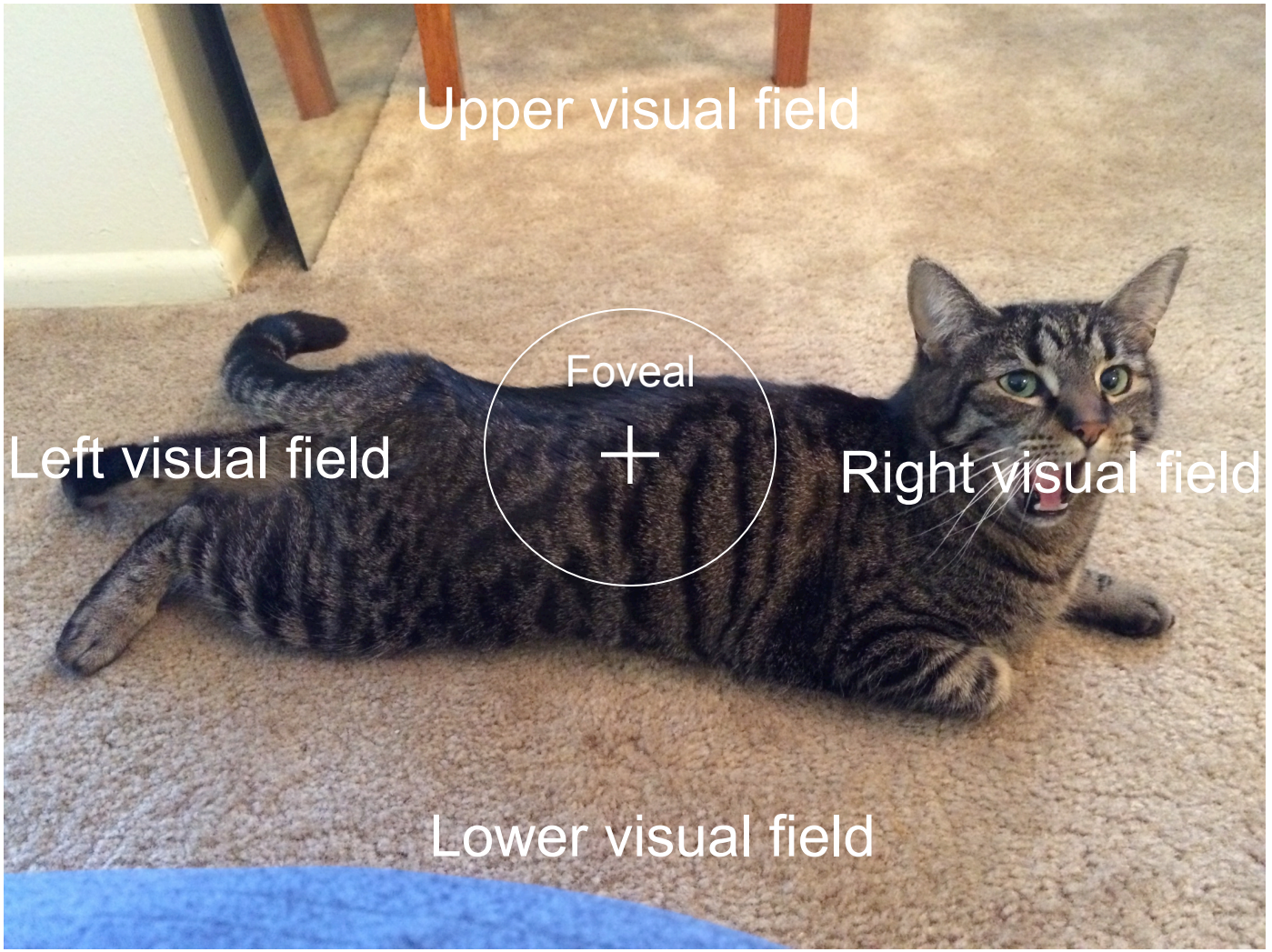


Photoreceptors

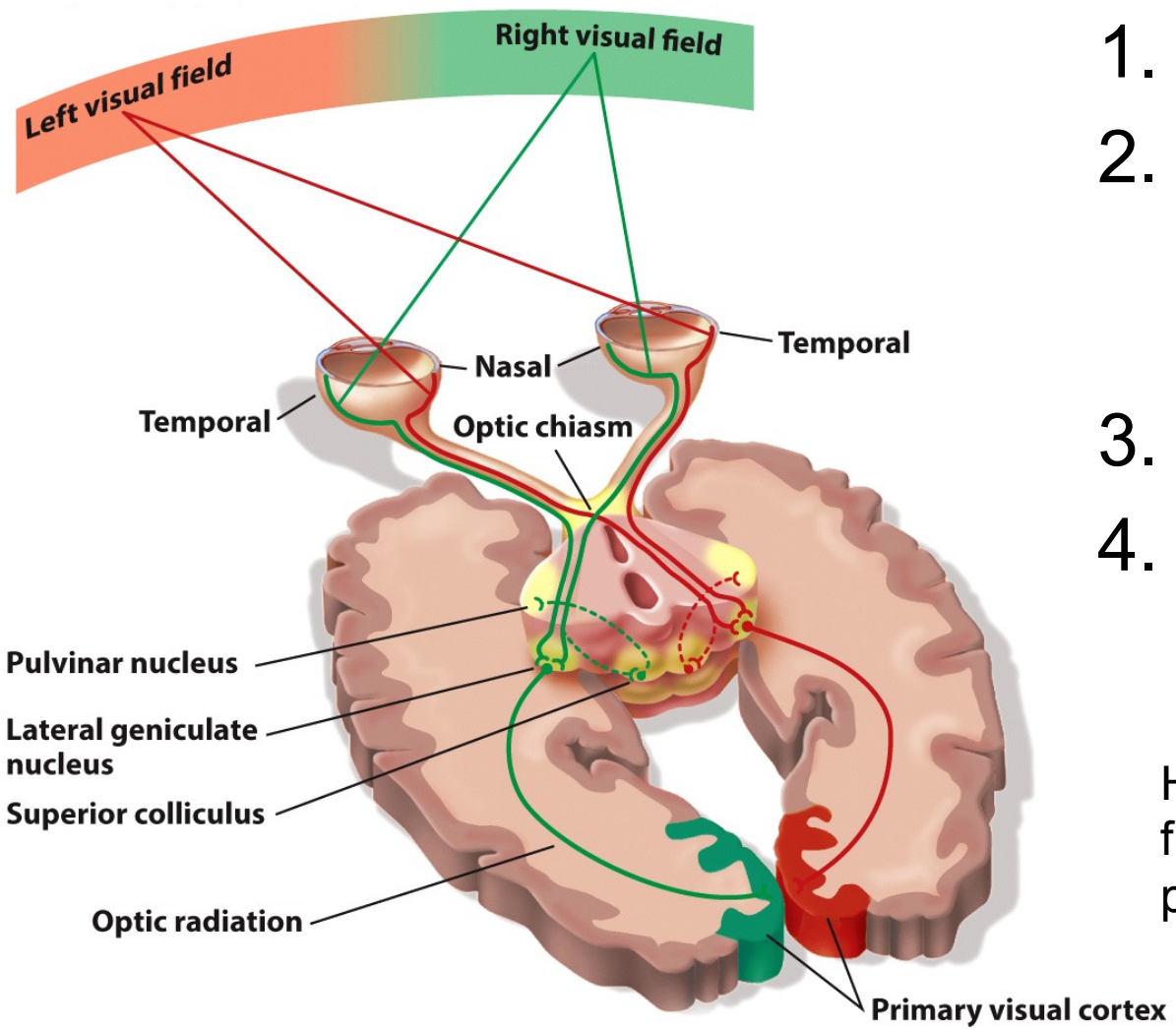


- Rods (sensitivity in dark) vs. cones (color sensitivity).
- Cones have optimal tuning to specific frequencies.

Visual field



Flow of information from optic nerve to V1



Visual pathway

1. Light enters retina
2. Peripherals (nasal) cross at optic chiasm
3. Thalamus (LGN)
4. Visual cortex

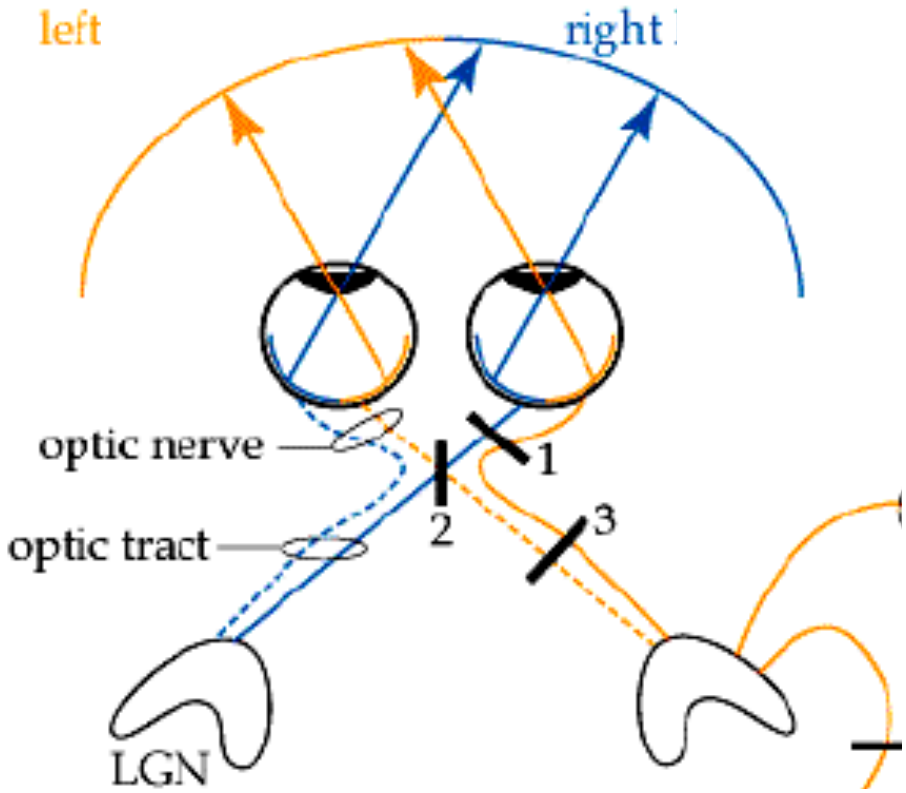
Hemifield – the part of visual field that each hemisphere processes

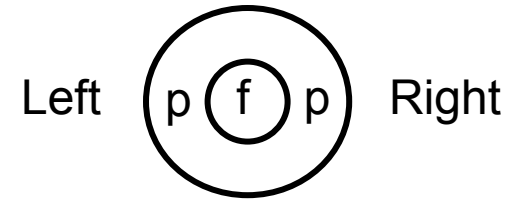
Optic Nerve: Visual hemifields

peripheral ->

<- peripheral

<- Binocular region ->

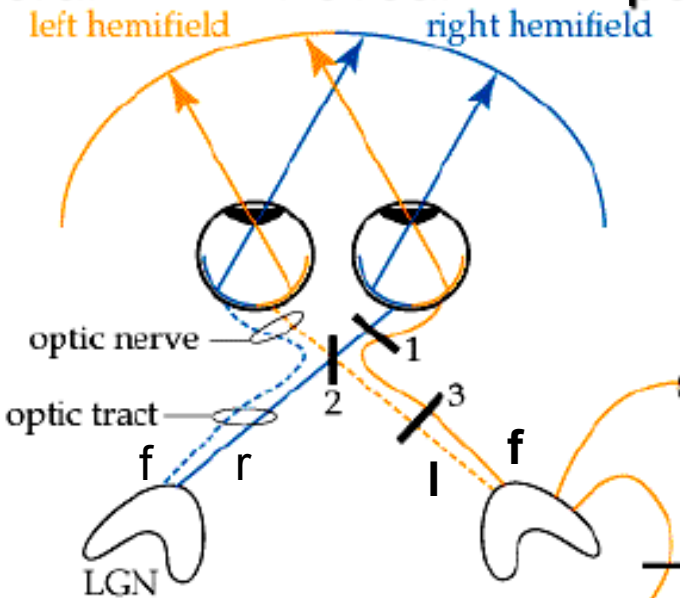




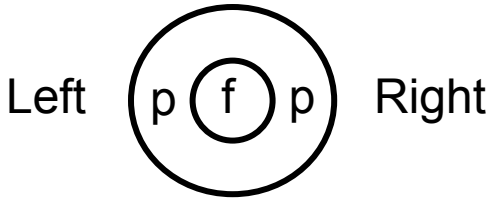
Visual field for one eye

- Foveal – goes to both hemispheres
- Peripherals – go to opposite hemispheres
  - Left visual field goes to right hemisphere
  - Right visual field goes to left hemisphere

peripheral -> <- Foveal -> <- peripheral



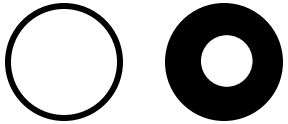
What the lesions do



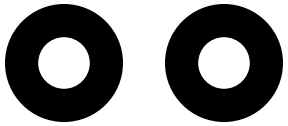
Visual field for one eye

L R

- Lesion 1: Blindness in one eye (right)

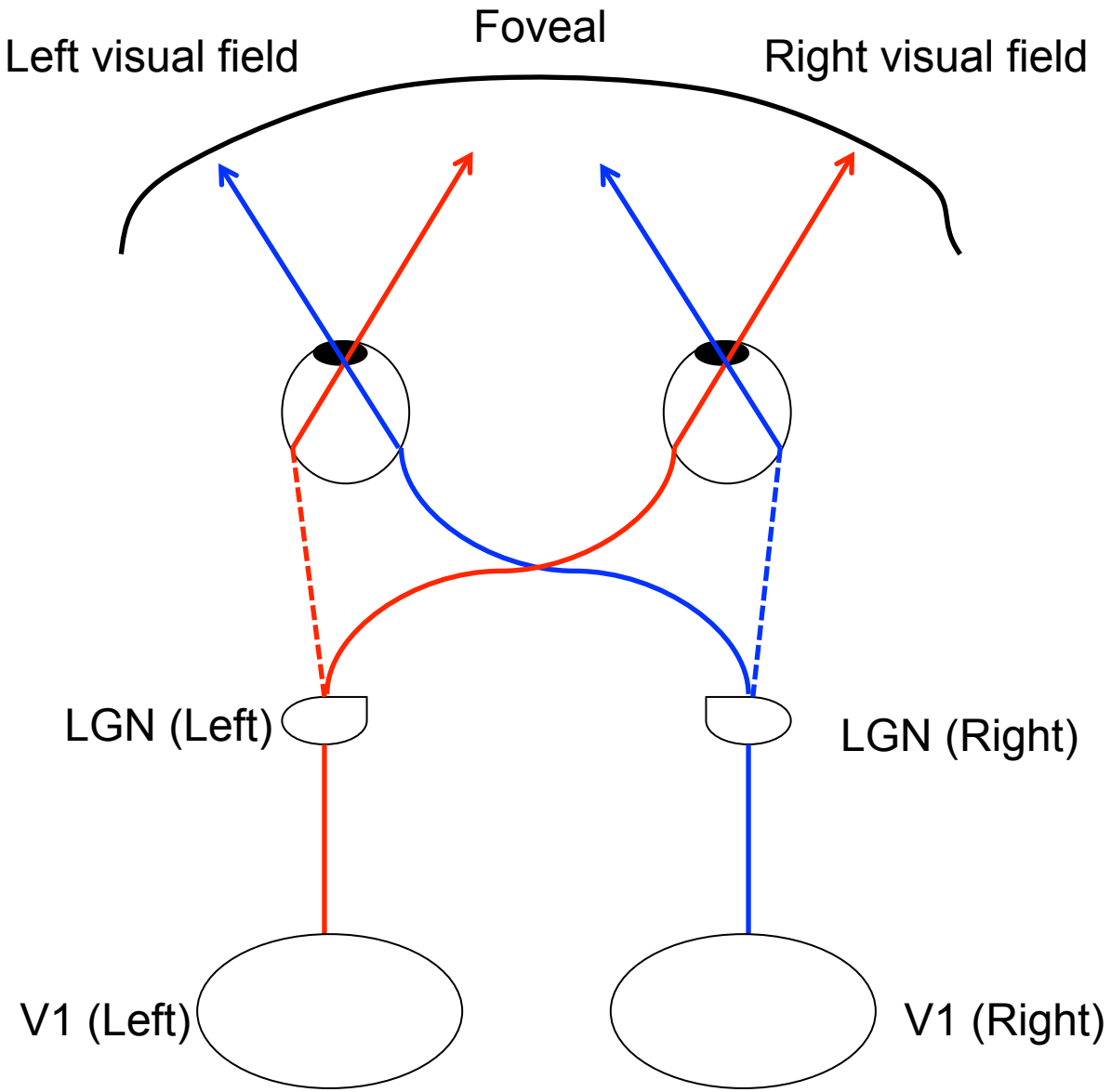


- Lesion 2, No peripheral vision on both sides.

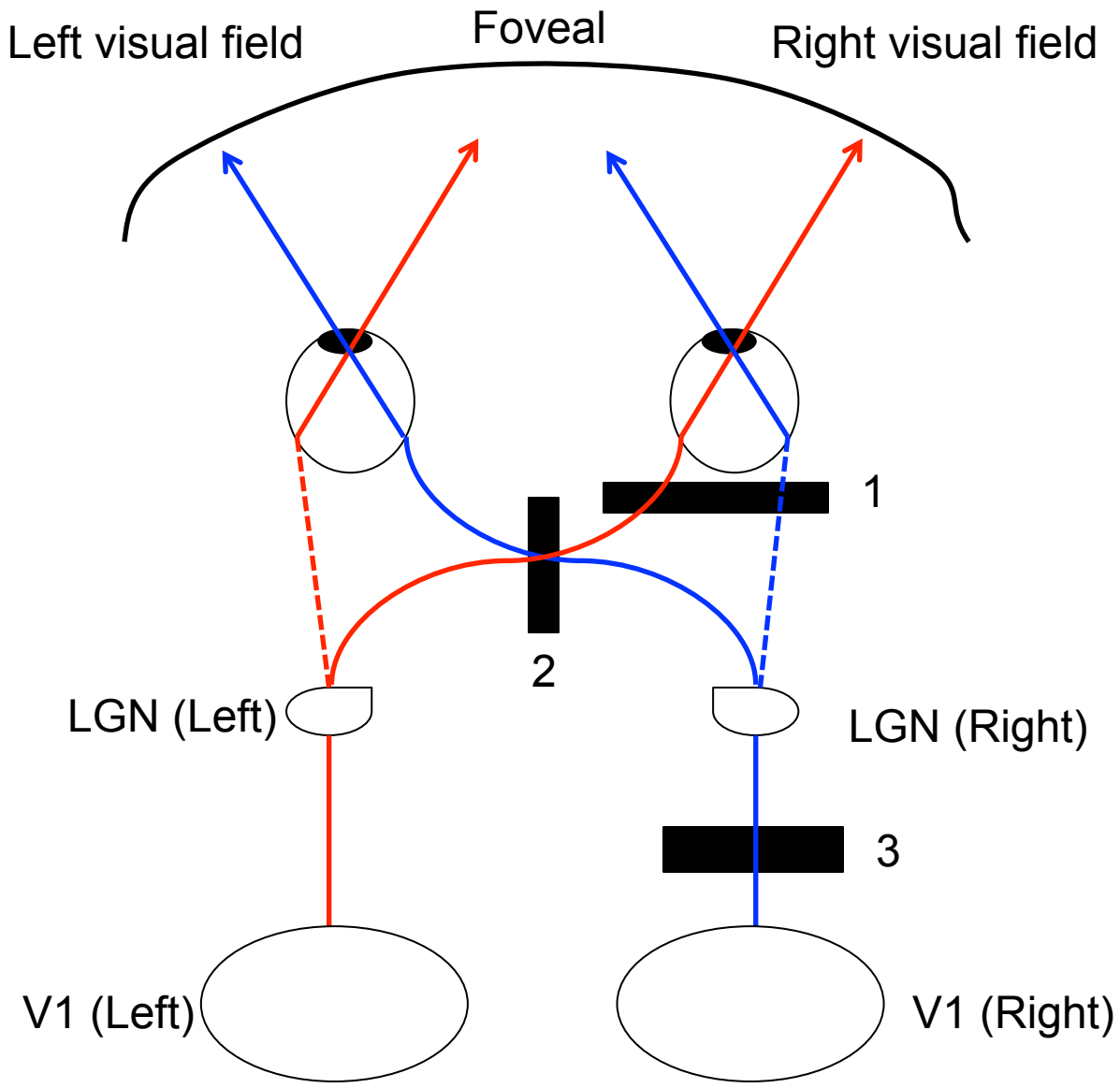


- Lesion 3: Loss of left hemifield

Visual pathway

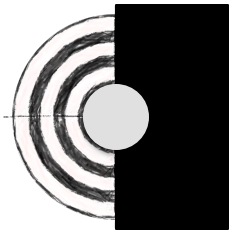


Visual pathway lesions



Visual field

1



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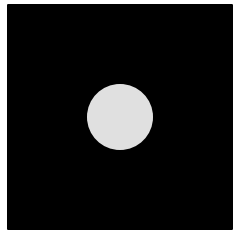

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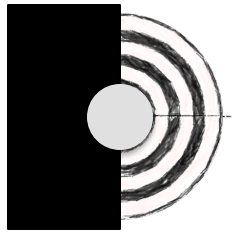
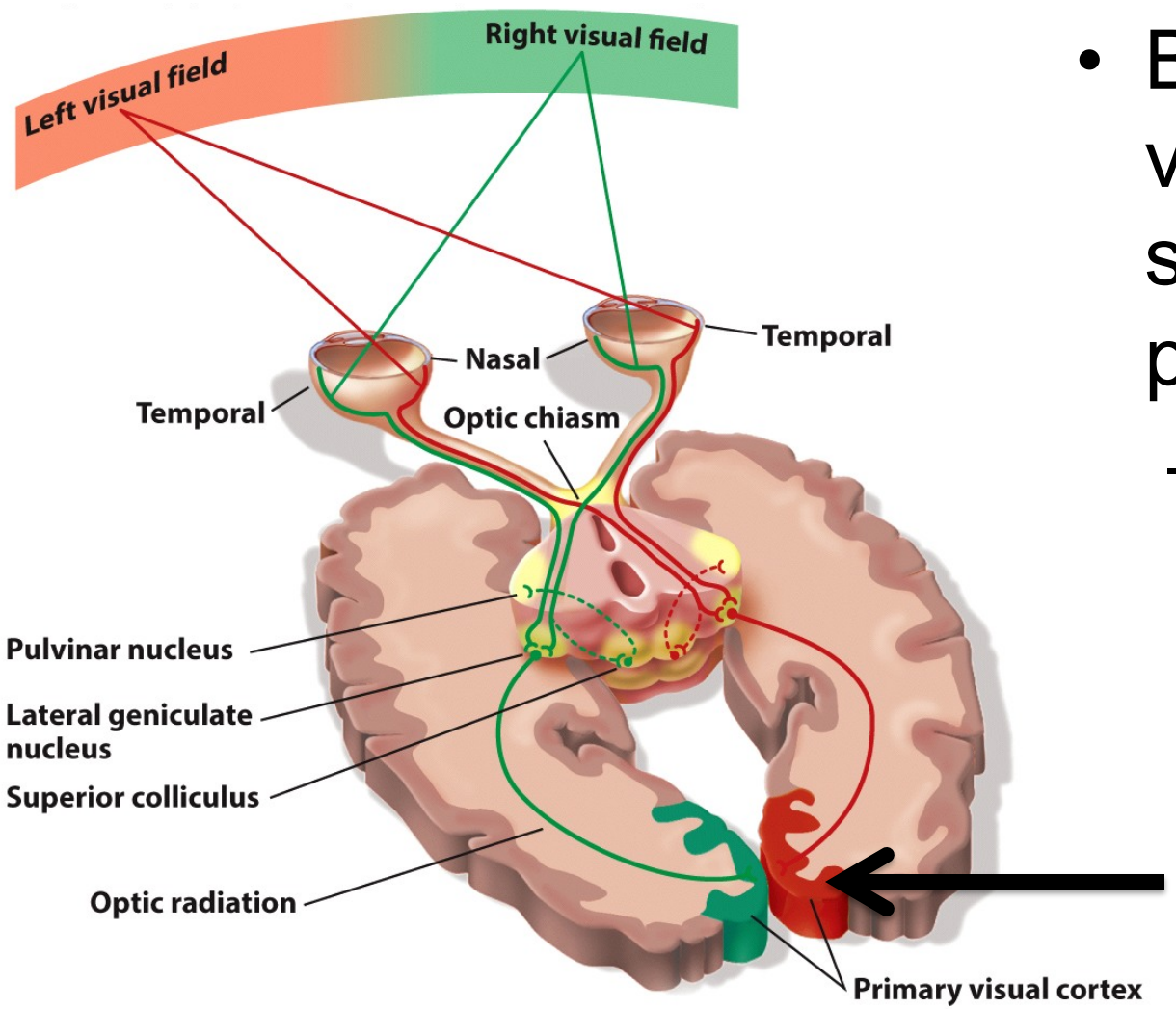


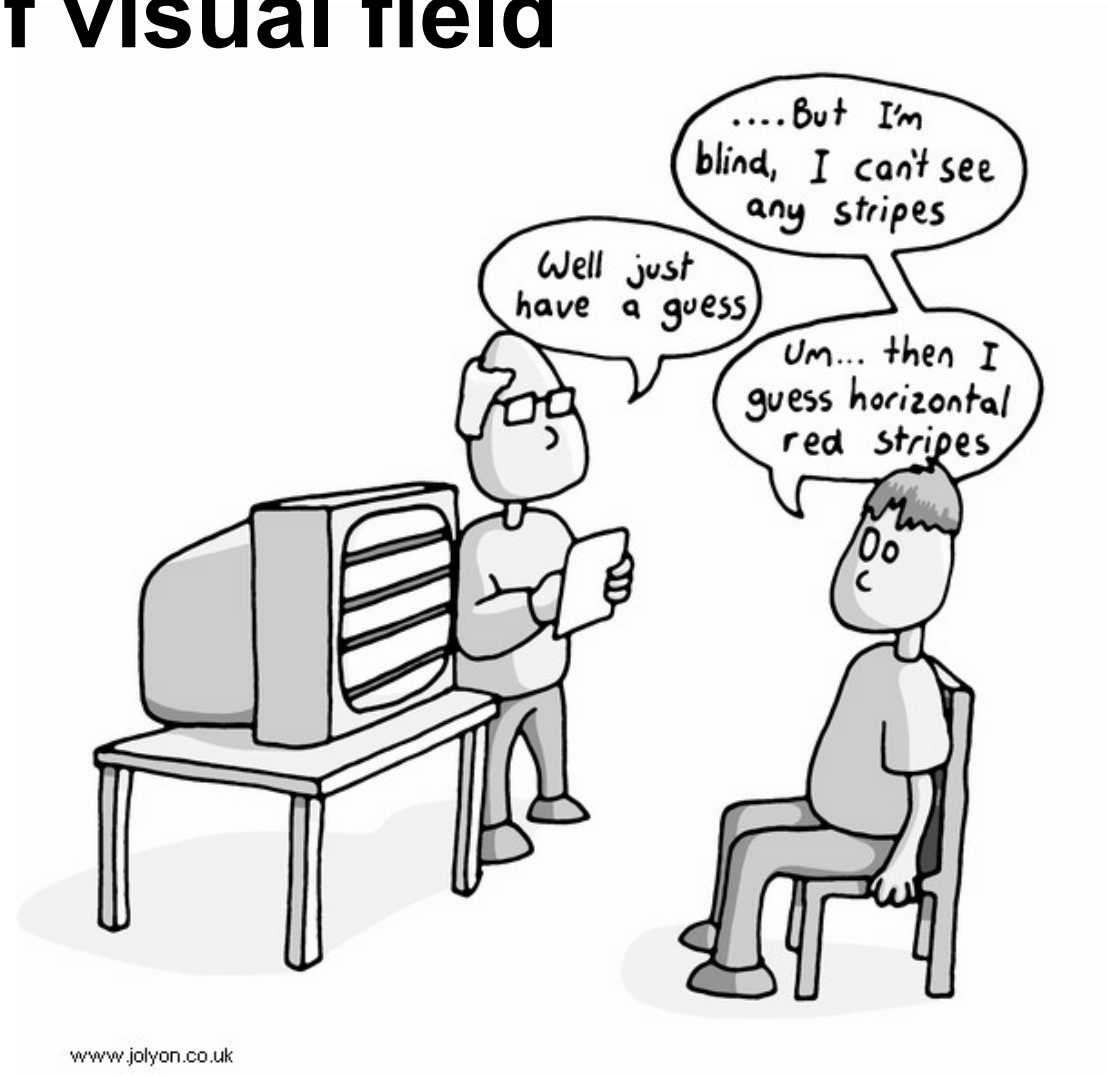
Flow of information from optic nerve to V1



- Cortical blindness
- But residual vision through subcortical pathway
  - Motor responses to “invisible”

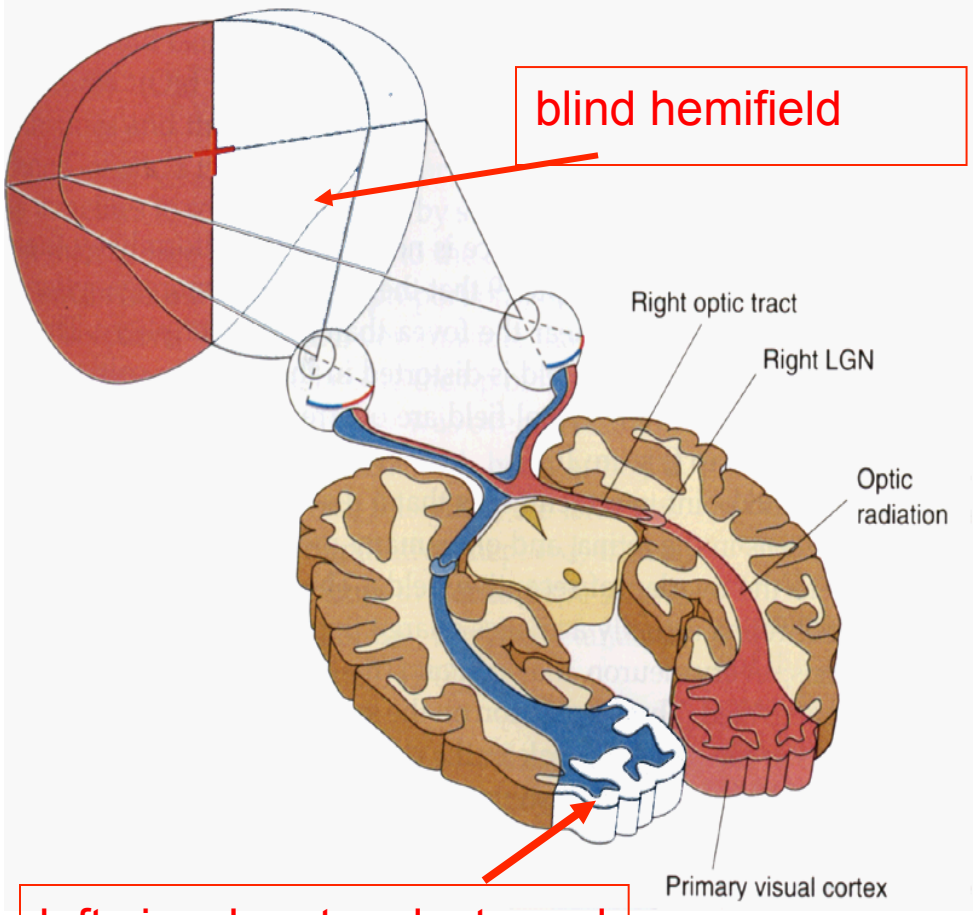
Lesion here?

Blindsight: some perception in “blind” parts of visual field



www.gla.ac.uk

Blindsight: some perception in “blind” parts of visual field



Patient fixates cross and test for function in the blind hemi-field (make them guess)

In the blind field, patients can identify stimulus properties

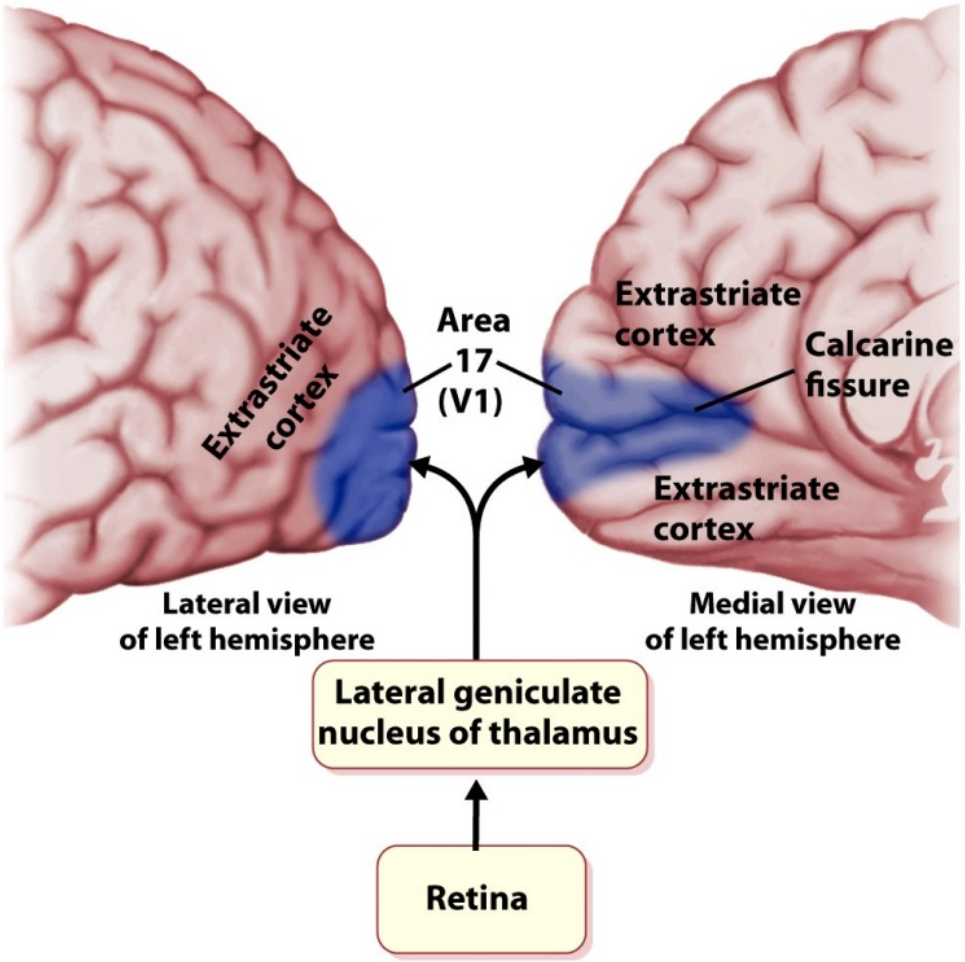
- direction of motion
- size
- line orientation
- simple shapes

How does this happen?

- Subcortical pathways
- residual V1 function

Weiskrantz

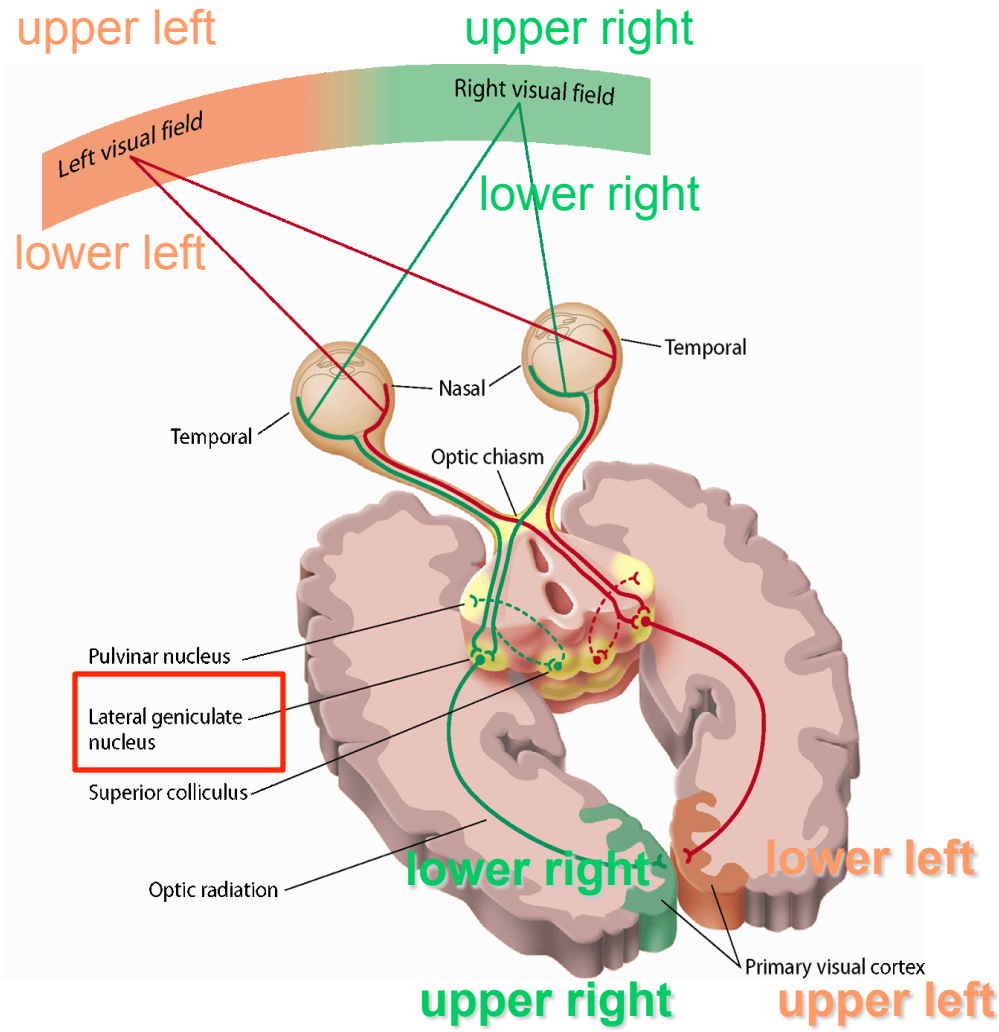
Primary Visual Cortex, V1



- Upper visual field = inferior to calcarine
- Lower visual field = superior to calcarine

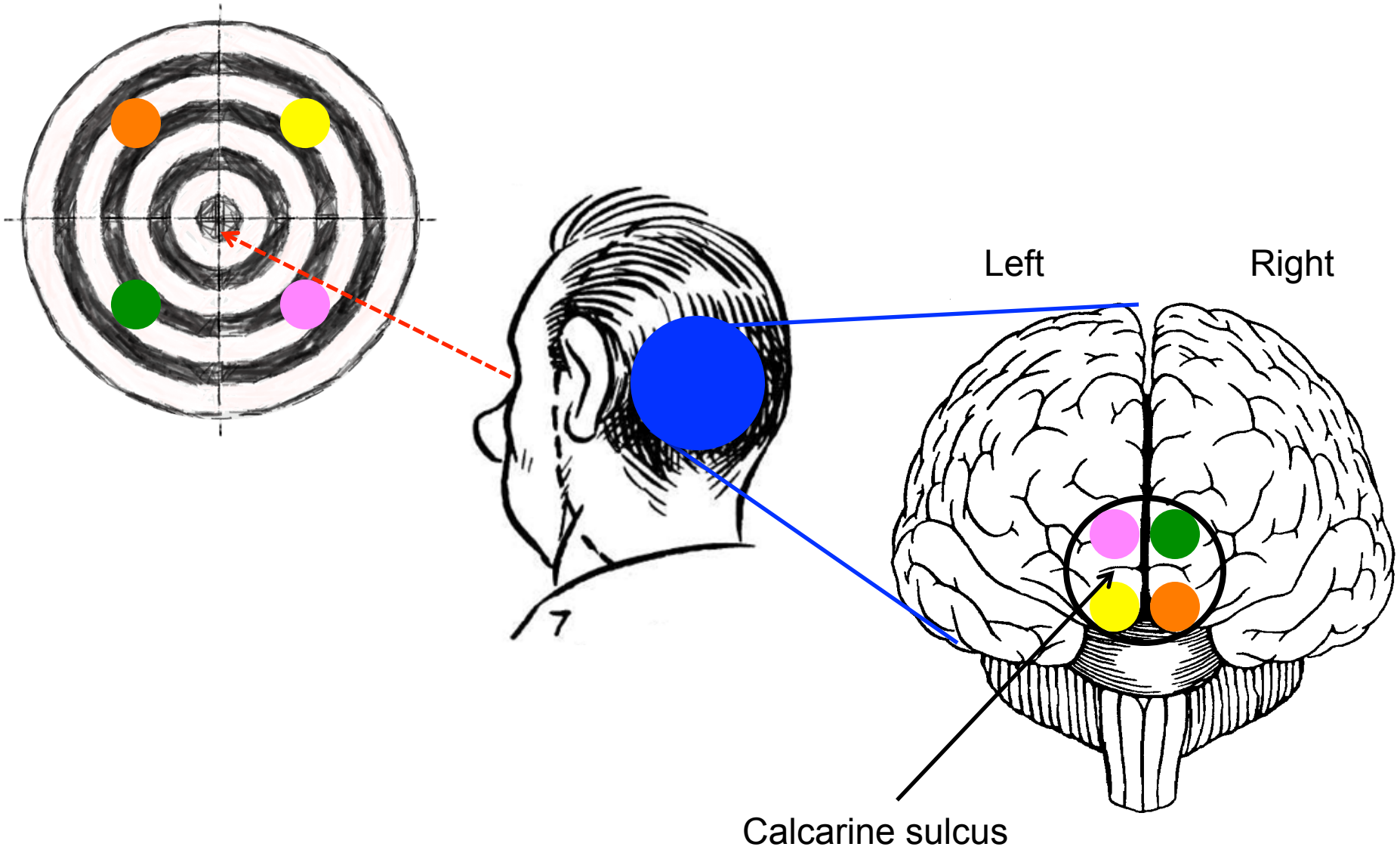
Calcarine sulcus divides upper + lower hemifields.

Inversion of visual world in cortex



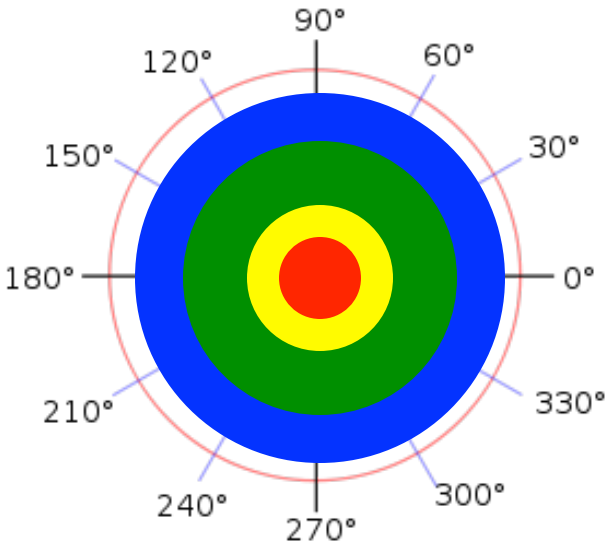
Visual world is flipped in visual cortex

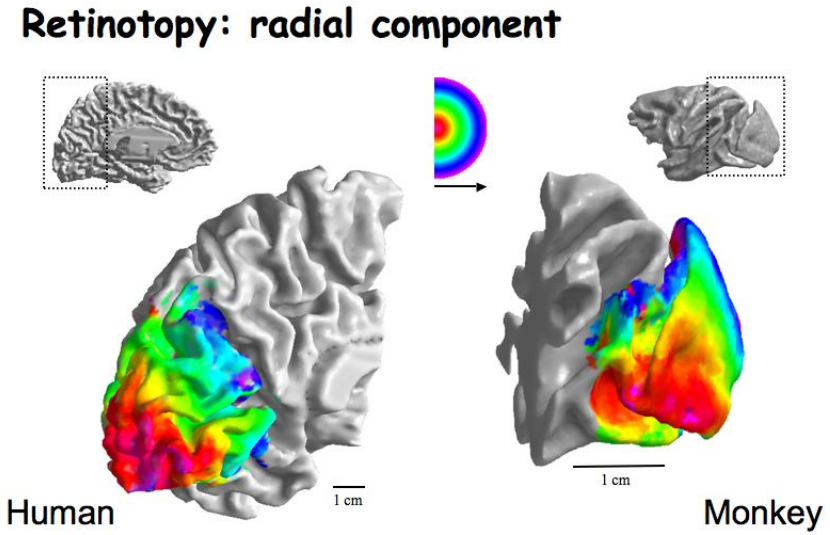
Visual field and visual cortex



Organization of visual cortex

- topography of the visual world is preserved in V1~v4

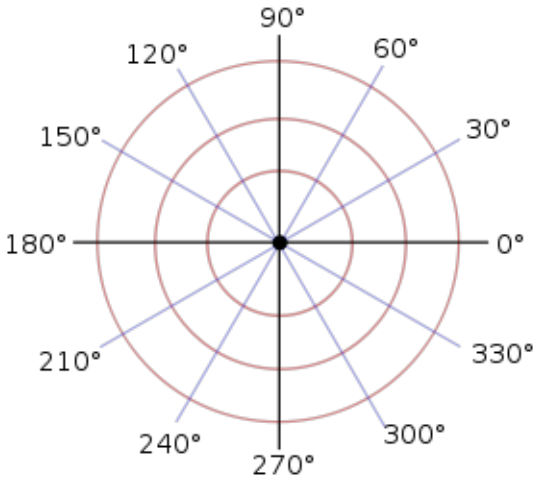


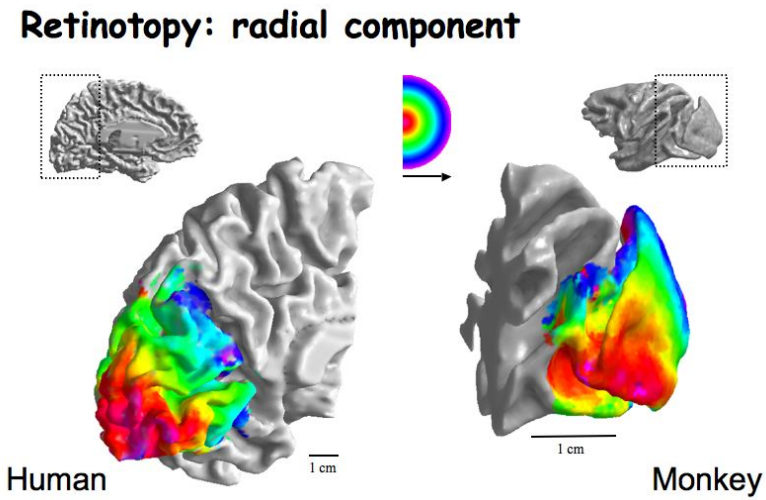


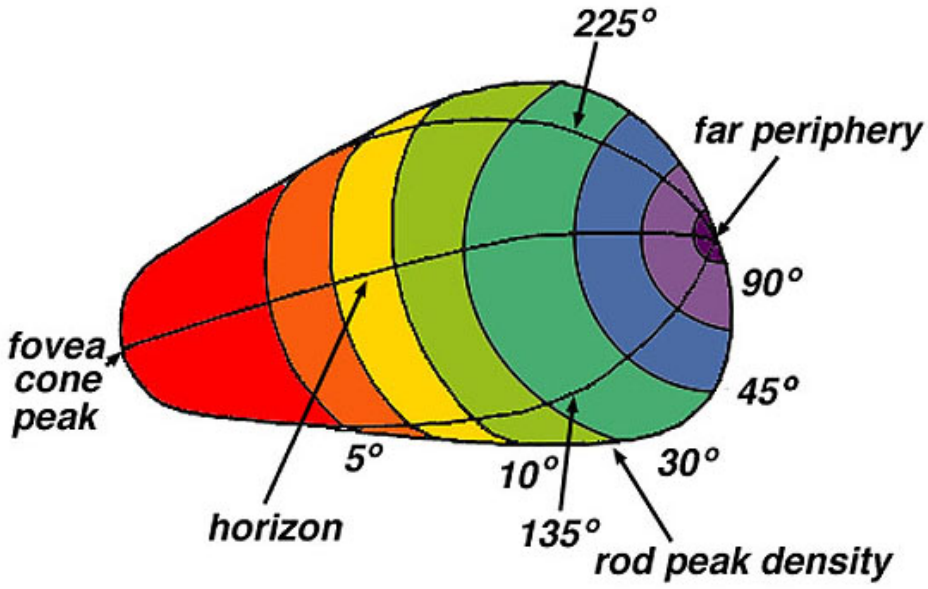
http://www.cns.nyu.edu/~david/courses/perception/lecturenotes/what-where/what-where.html

Transform Cartesian to Polar Coordinates

- Fovea is most posterior representation in V1 (back of head)
- Peripheral is more anterior.





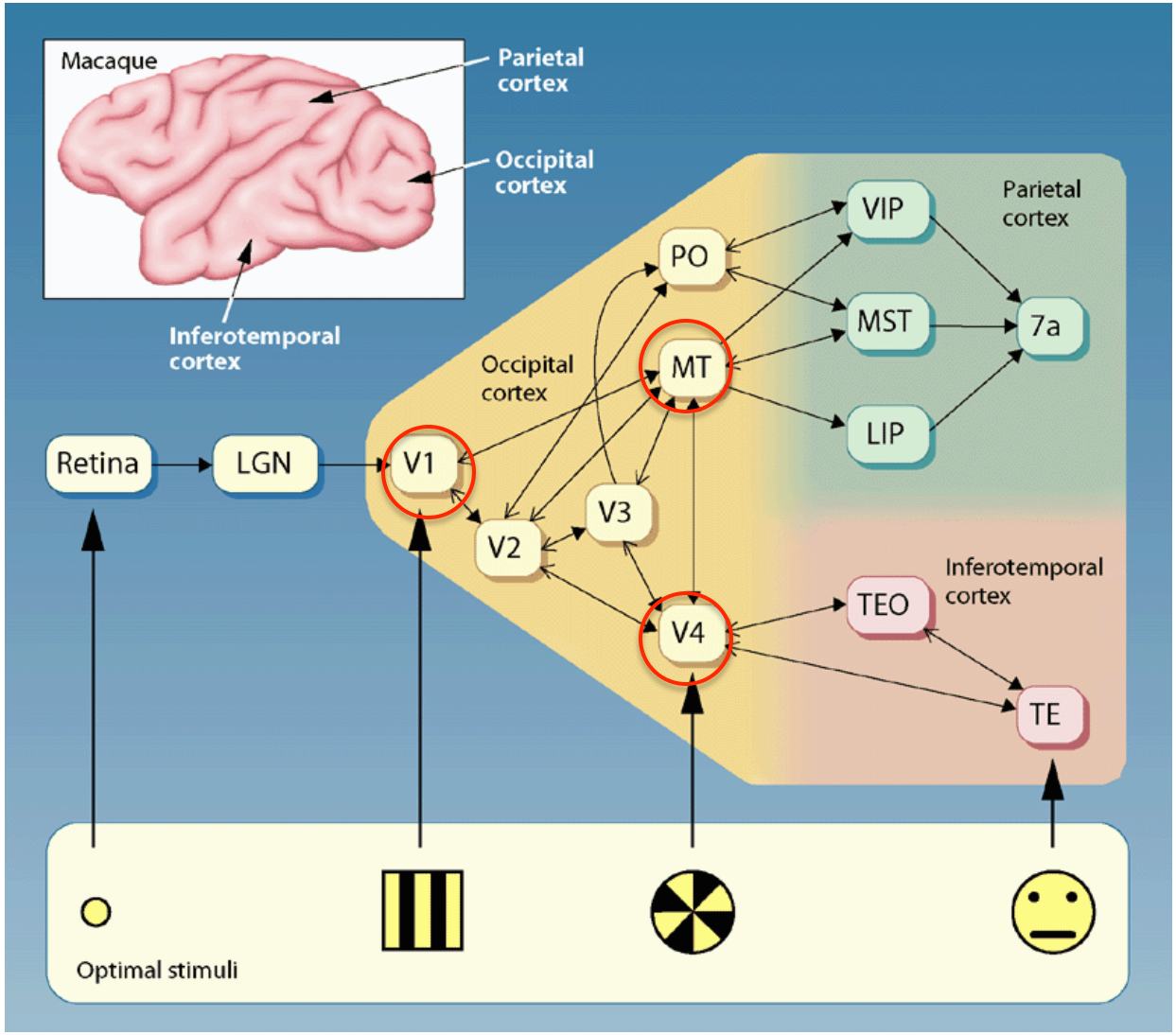


- What could you do with knowledge of how visual information is mapped onto visual cortex?

Presented clip

Clip reconstructed from brain activity

Next stop: V4, MT



Dorsal pathway

Ventral pathway

Van Essen and DeYoe 1995

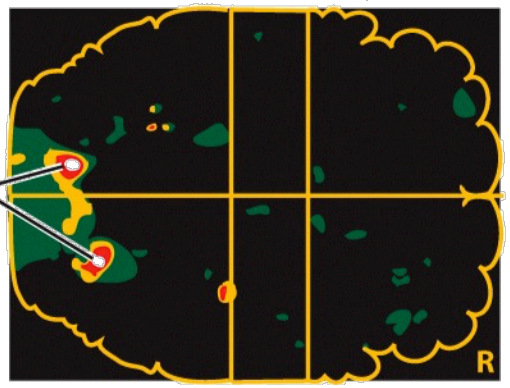
“Modules” within the visual system

- Areas in ventral pathway are thought to be selective for specific types of information (e.g., faces)
  - Recall debate between localizationism and holism
- Functional modularity (domain-specificity)
  - Encapsulated information (e.g., color, faces)
- Distributed processing (domain-generality)
  - rely on distributed or “emergent” properties of activity in multiple brain regions.

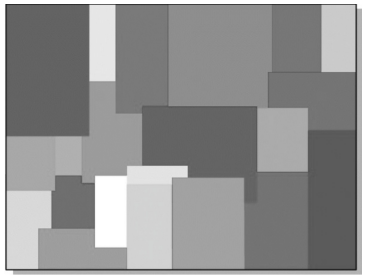
Specialized feature processing in the human brain

V4

Activated areas during color stimulation



Color-gray



Zeki, S., 1993.

What does someone with MT damage see?

Lesions to V5/MT can produce akinetopsia, a deficit in motion perception

What does someone with V4 damage see?

Lesions in V4 can lead to achromatopsia (color agnosia), a deficit in color perception

how the world might look to a person with achromatopsia

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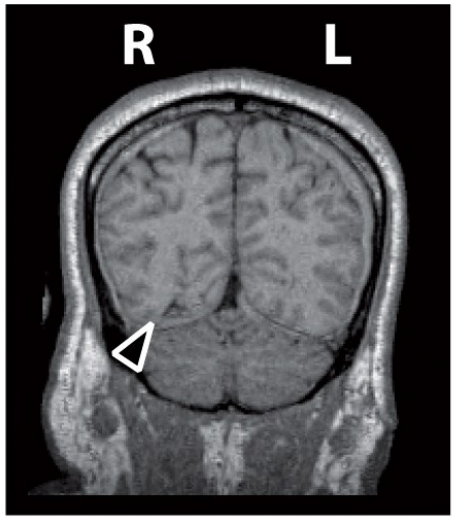
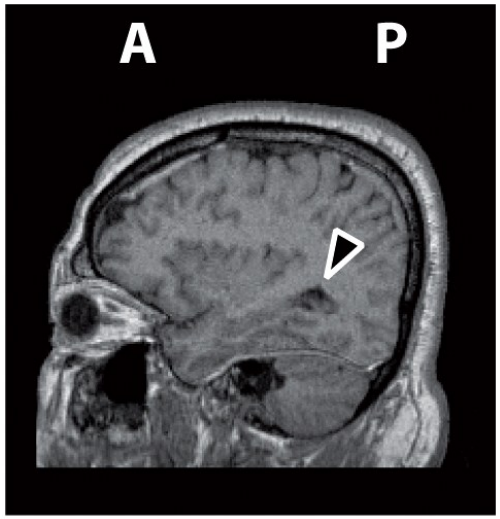
Double dissociation

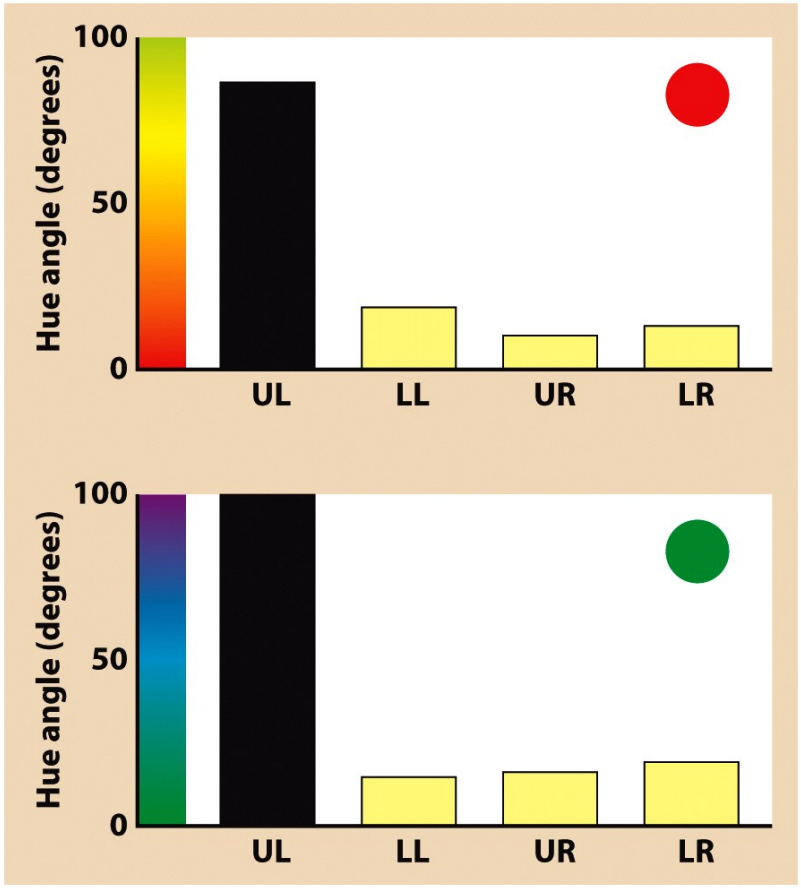
	MT Lesion	V4 Lesion
Motion perception	X	✓
Color perception	✓	X

Color perception with a unilateral lesion of V4



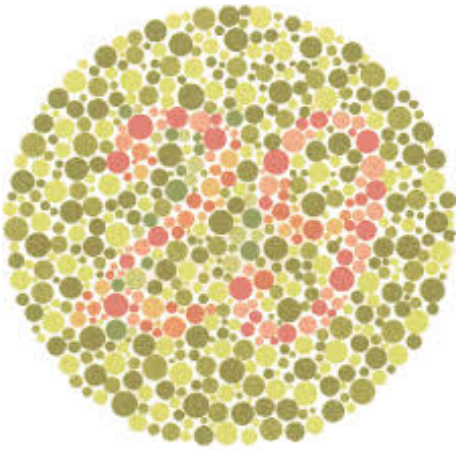


UL = upper left
LL = lower left
UR = upper right
LR = lower right



Achromatopsia vs. Color Blindness

- V4 lesion leads to cerebral achromatopsia (color agnosia).
  - Loses all color vision regardless color hues
- Color blindness is caused by problems with cones in retina
  - Often red-green color blindness when one cone is deficient



Perception is not a faithful/veridical replication of the environment

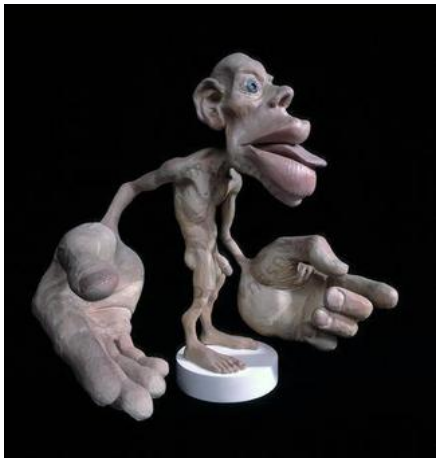
- Functional overrepresentation in cortical organization
  - Sensory maps
  - Cortical magnification
- Cortical plasticity
- Illusory perceptual filling-in: perceptual reconstruction
- Metaphor representation

Perception is not a faithful replication of stimuli in the environment

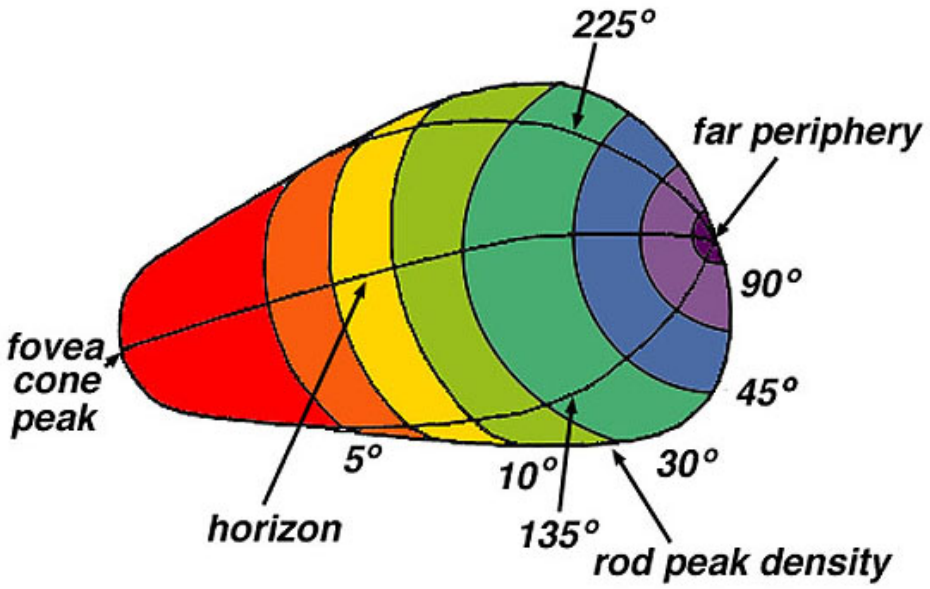
- Perceptions are constructions by our CNS and reflect the behavioral function of sensory information.

Visual system: over-representation of central vision.

Somatosensory system: over-representation of thumb, mouth, tongue .



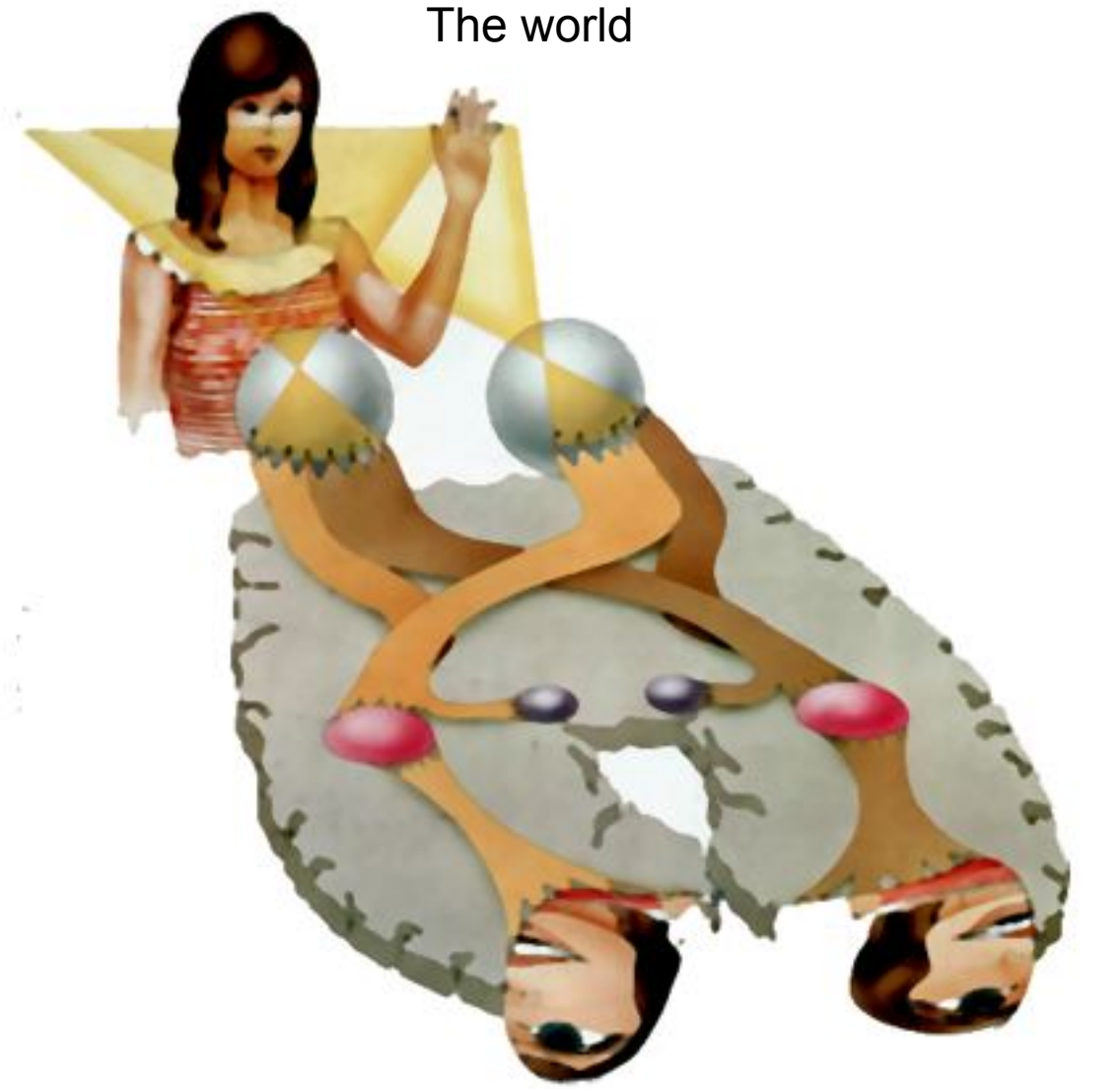
Visual cortex – magnification at fovea

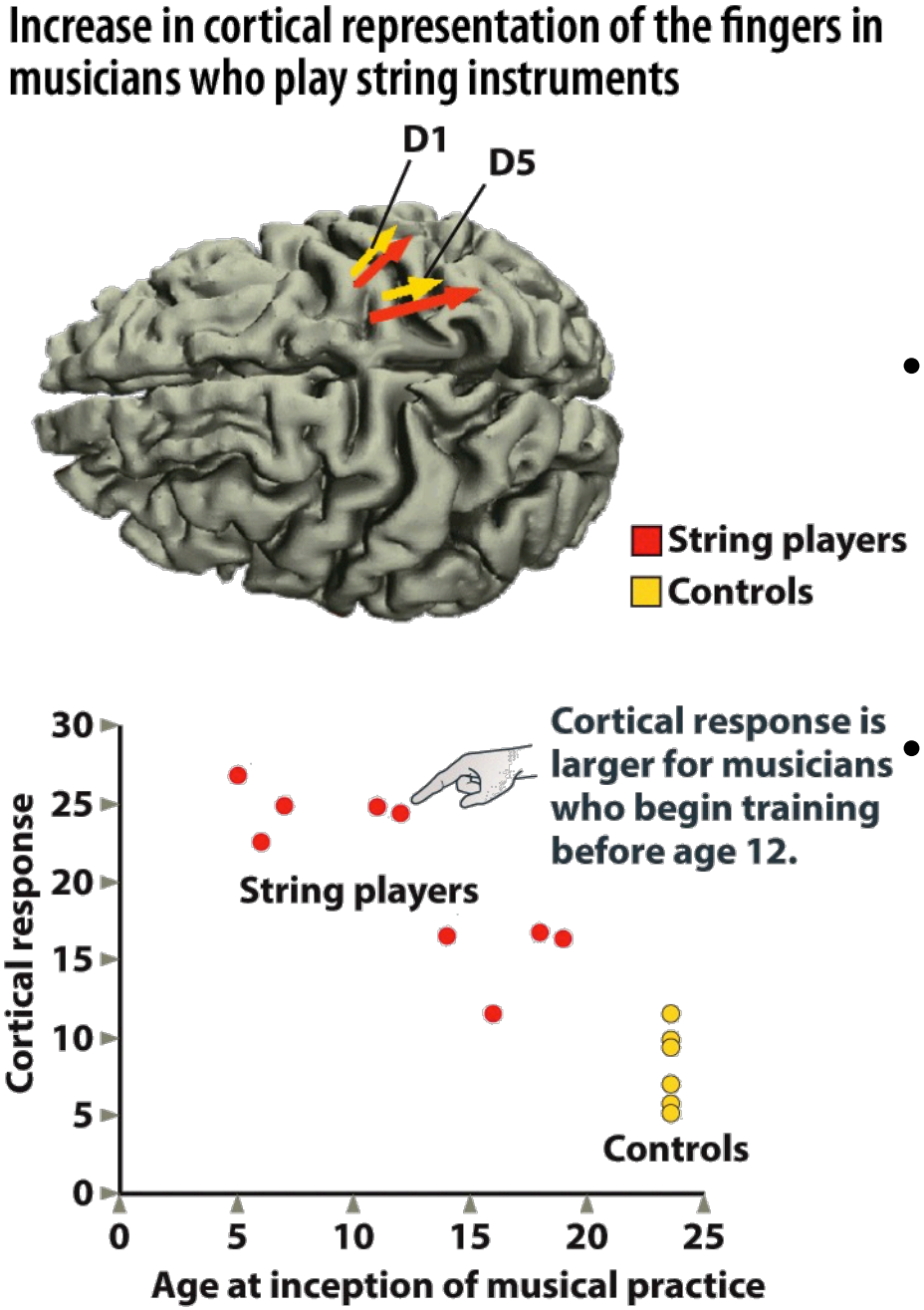


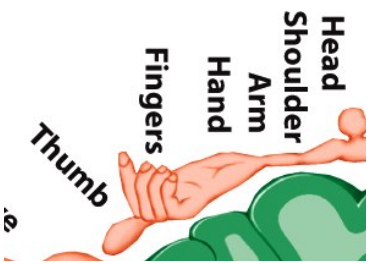
- Large cortex involved in processing foveal information
  - Less cortex as you move more peripheral

Foveal magnification

Cortical Magnification







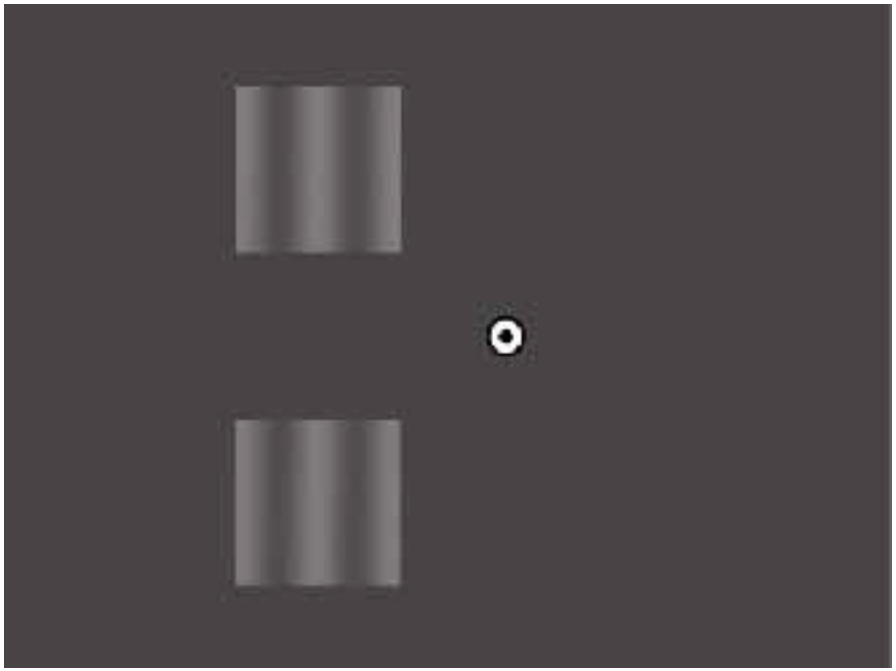
- Larger responses in somatosensory cortex following stimulation of thumb (D1) and pinkie (D5) for musicians than controls
- For musicians, the earlier musical training stated, the larger responses

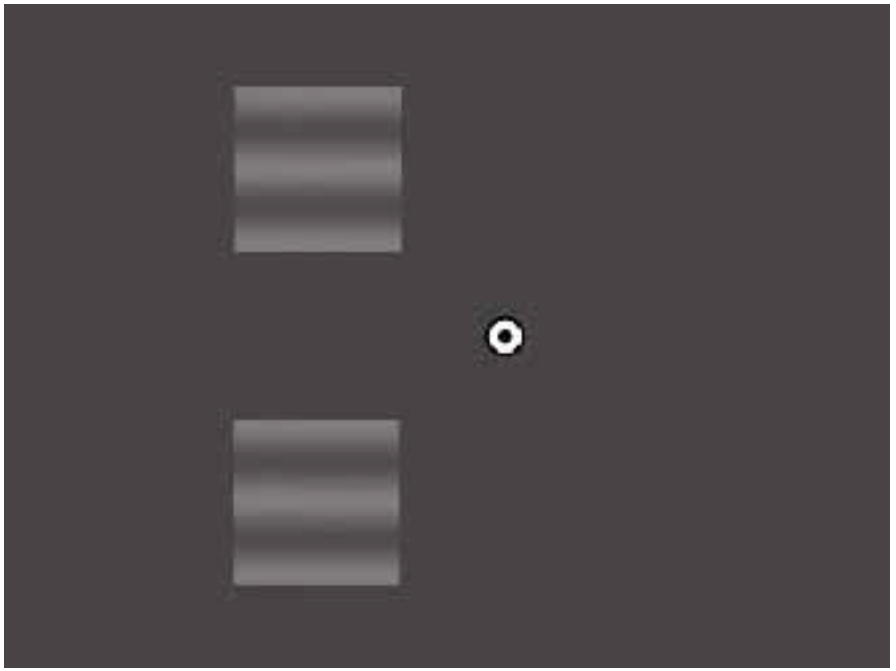
Gindrat et al. (2015)

Cortical Magnification: sematosensory

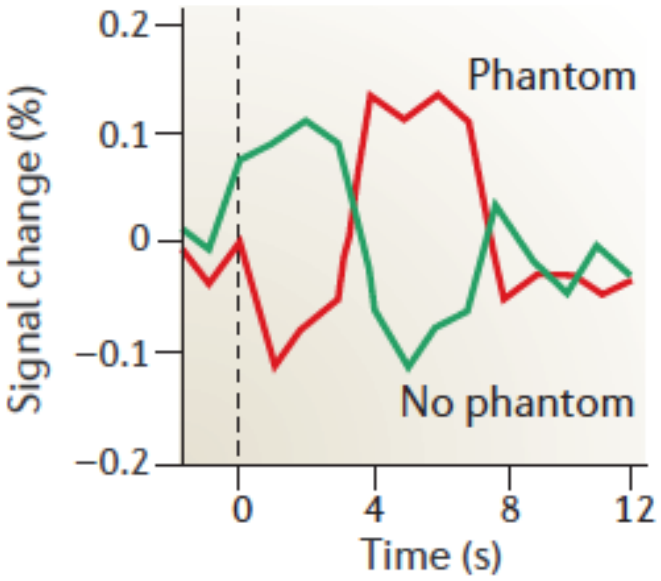
- Enhanced thumb sensory representation for smartphone users
- Can be induced with just 10 days of touch screen use

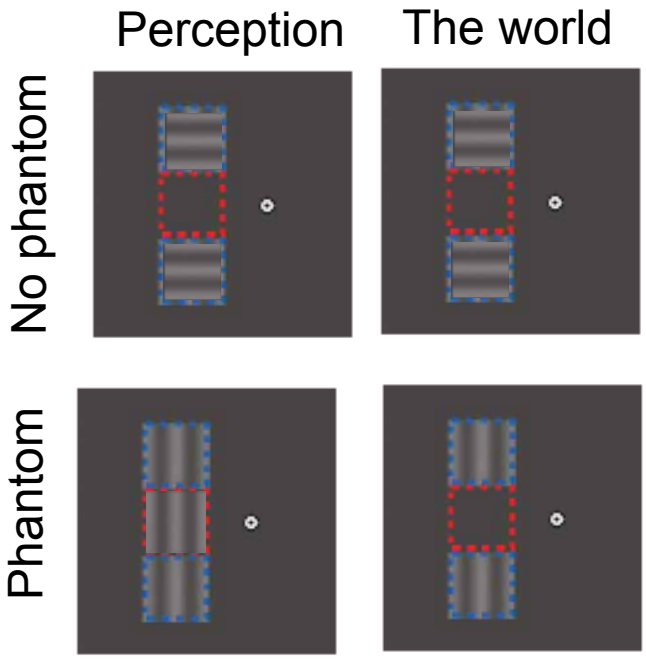
Perceptual Filling-in: Reconstructive

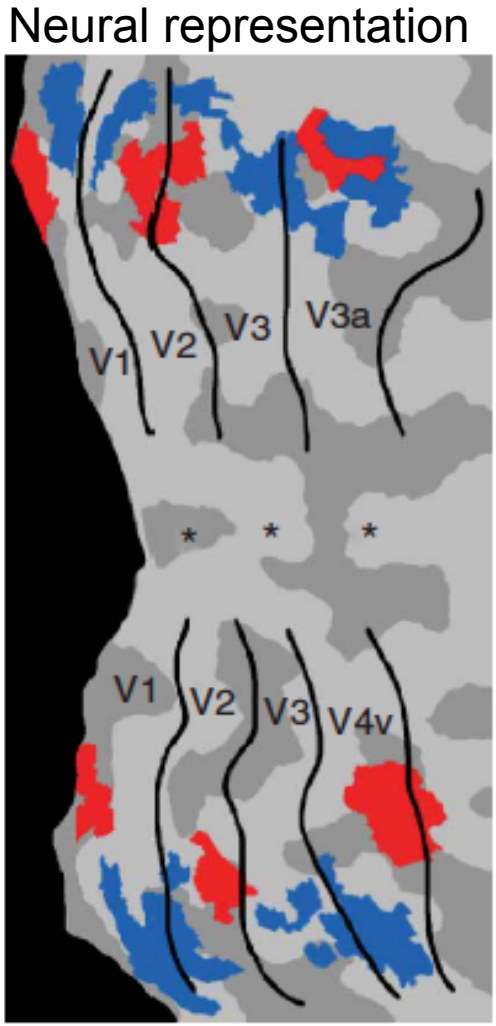




Perceptual Filling-in: Reconstructive







- The activity in the gap region (red square) increased after the phantom was perceived, and decreased when the phantom disappeared
- Providing the neural mechanisms of perceptual filling-in

Meng et al. (2005)

Effects of Cog-social Factors on Luminance Perception

- Positive emotion makes things to look lighter (Meier et al., 2007)
- Recalling moral behavior increases perceived brightness (Banerjee et al., 2012)
- Smiles brighten up perceived facial lightness (Song et al., 2013)

Two possibilities

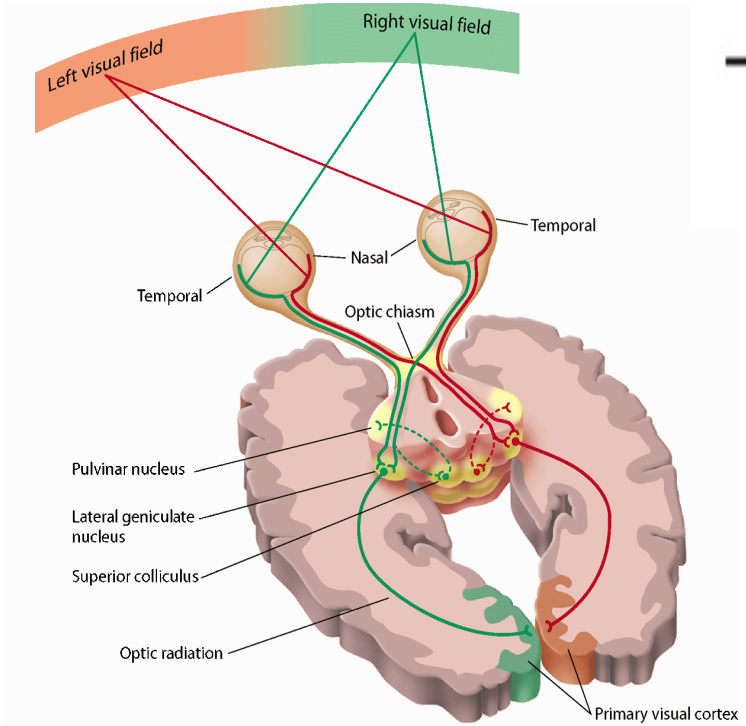
1. Metaphor representation perspective
   - Light and darkness have always been symbols of good and evil
   - *Biases* us to think they're lighter or darker
2. Cognitive neuroscience perspective
   - 'Lighter' metaphors change our *sensation*

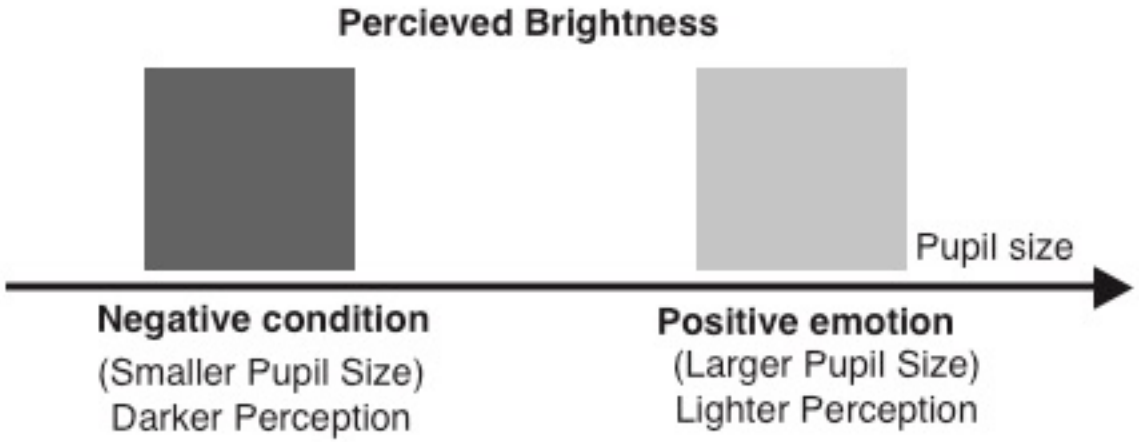
Cog-social Factors & Perception

Metaphor representation perspective

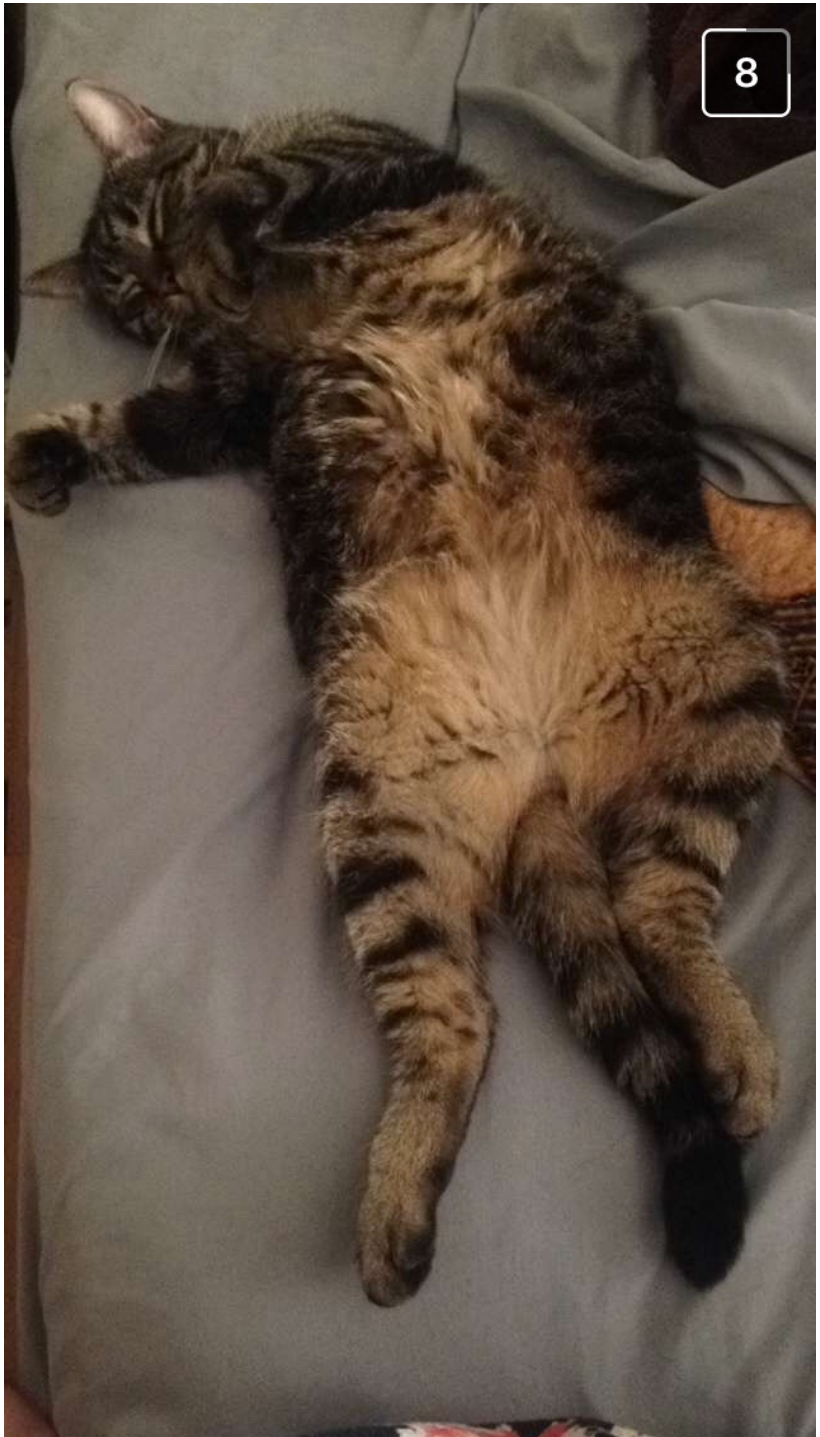
"bright smile":

CogNeural mechanism





1. Emotion activates Locus Coeruleus LC, and then modulating pupil size Via LC-Norepinephrine system (LC-NE)
2. Consequently, change perceived brightness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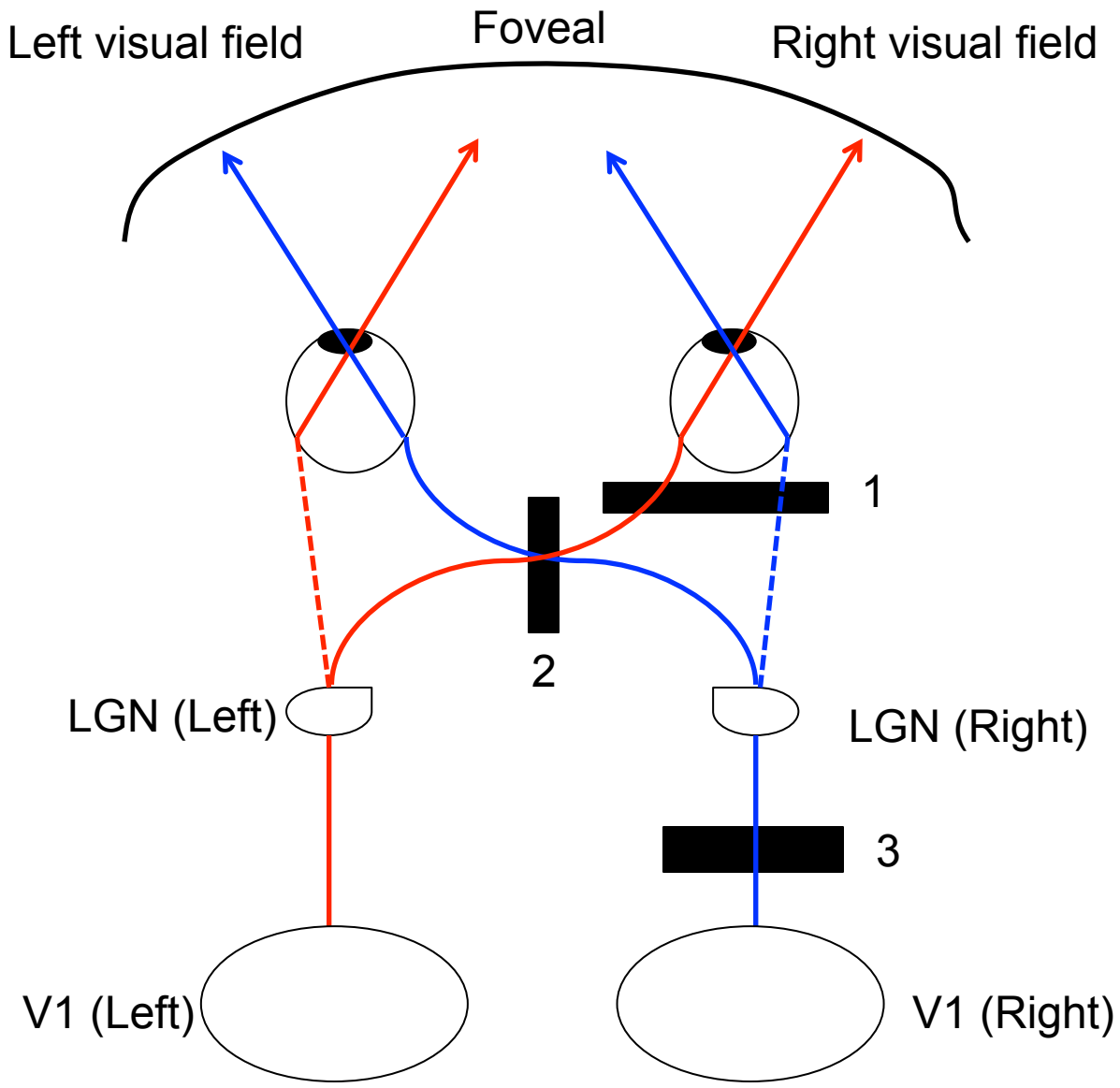
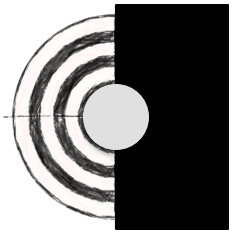
Visual pathway lesions

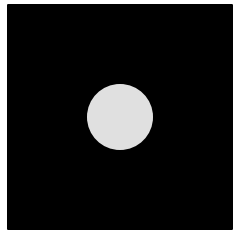


Visual field

1



2



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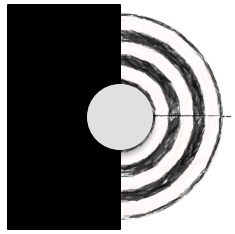
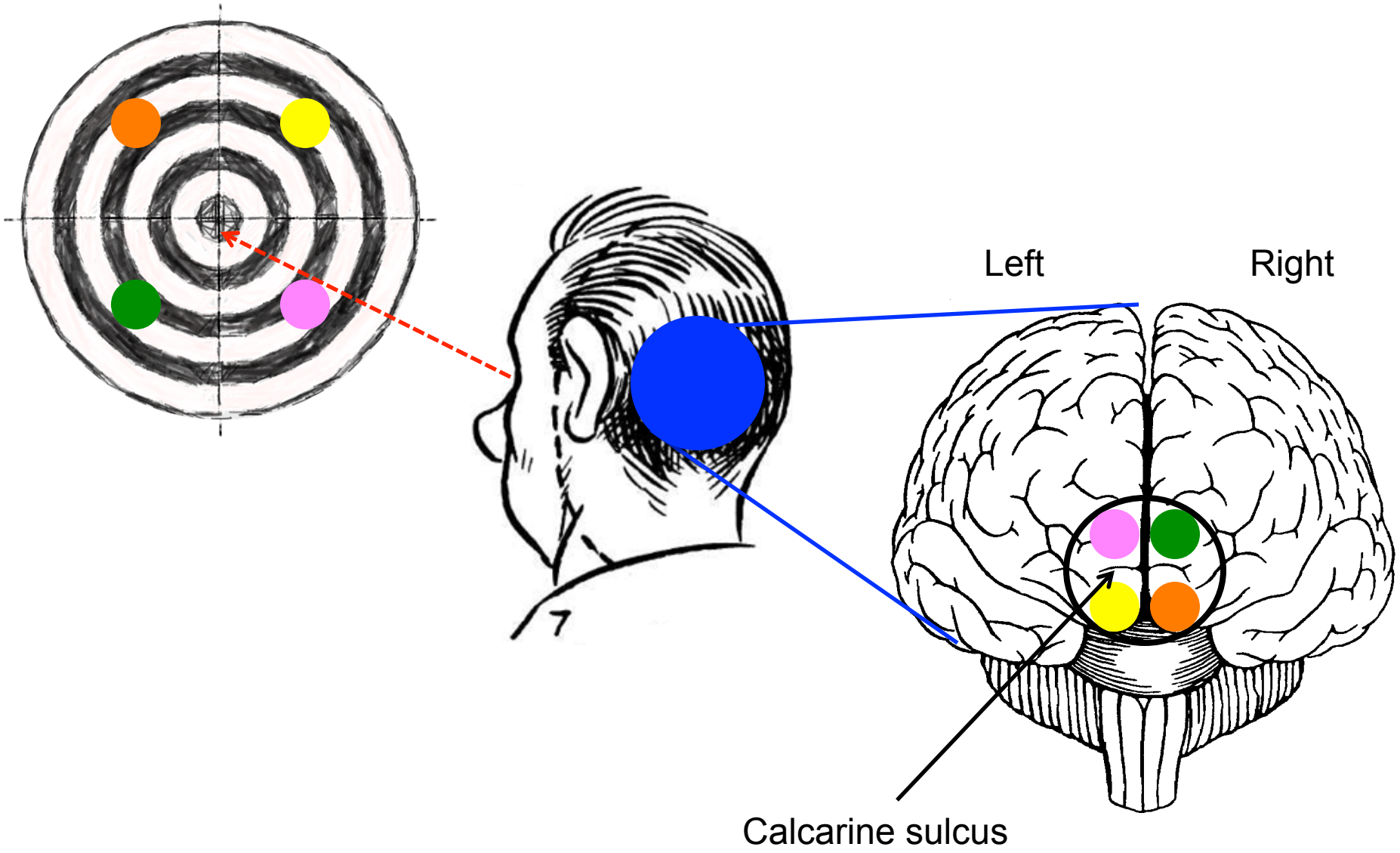


Visual field and visual cortex

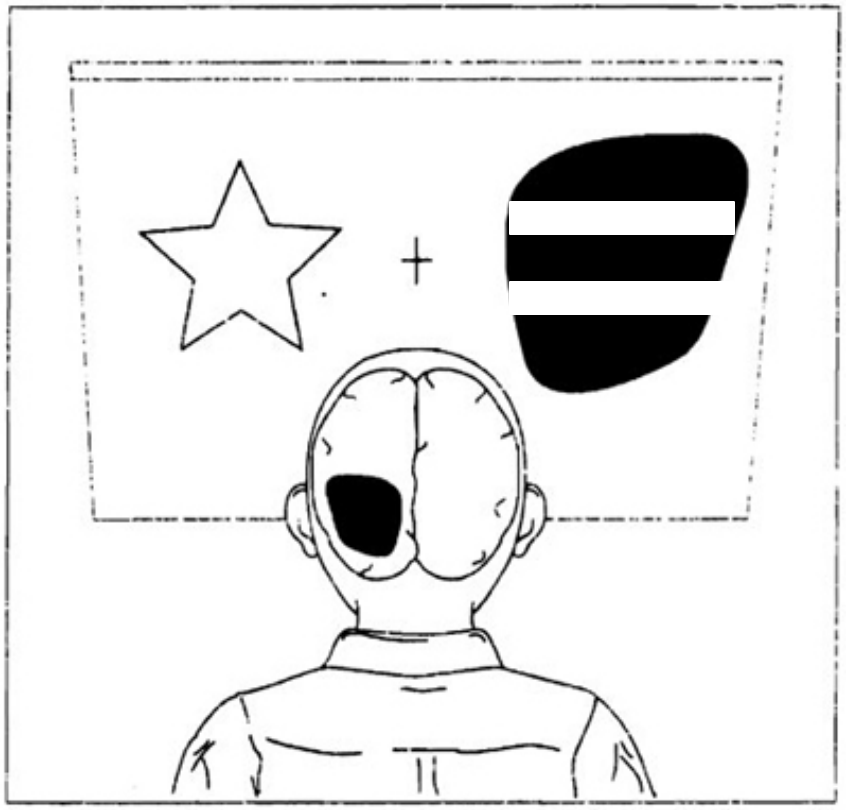


Blindsight: some perception in “blind” parts of visual field

Visual pathway so far: cortical visual pathway

- Blindsight – subcortical pathway

Blindsight



In the blind field, patients can identify stimulus properties (unconsciously)

- direction of motion
- size
- line orientation
- simple shapes

How does this happen?

- Subcortical pathways
- Residual V1 function

Visual cortex: V4 and MT

V4 lesion

MT lesion

Essentials: Vision

- Vision
  - Visual hierarchy & pathway
  - what happens with damages to different parts of visual pathway.
- Vision ≠ Camcorder: Flexible mapping between external world and perception
  - Functional overrepresentation
  - Cortical plasticity
  - Perceptual filling-in
  - Cog-social factors